# REGULATIONS
# FOR
# WASTEWATER TREATMENT
# AND
# LAND DISPOSAL SYSTEMS

**WILLIAMSON COUNTY, TENNESSEE**

**November 3, 2004**

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## SECTION 1.0 - GENERAL

### 1.1 PURPOSE

Williamson County has long recognized the need for providing alternatives for wastewater treatment and disposal. In 1988, the Growth Management Plan identified land treatment and disposal as a viable alternative for providing public sewer service to development within Williamson County. However, Williamson County also recognizes that these alternative wastewater treatment and disposal systems must be properly regulated and bonded in order to protect the public health and safety.

The Tennessee Department of Environment and Conservation (TDEC), Division of Water Pollution Control, has not developed guidelines or regulations for the land disposal of effluent from various treatment methods. While Williamson County believes land disposal of effluent is a viable alternative, these alternatives must be properly regulated, permitted and monitored. The Tennessee Department of Environment and Conservation has chosen to approve and permit land disposal systems using drip irrigation without the formulation of specific design criteria or regulations. Consequently, there appears to be a great deal of variety in the type of control mechanisms being placed upon the entities providing these services.

The Williamson County Commission, Williamson County Planning Commission, and the Williamson County Water and Wastewater Authority believe it is inappropriate to allow land disposal facilities to be constructed in Williamson County without proper regulations and control mechanisms. These guidelines have been prepared to set the minimum standards for wastewater land disposal systems within Williamson County. These guidelines are not intended to replace the role of the Tennessee Department of Environment and Conservation, Division of Water Pollution Control, but to only provide some additional requirements and a consistent approach to approval of land disposal systems within Williamson County.

Much of the information contained in these guidelines has been taken directly from the Tennessee Department of Environment and Conservation's Design Criteria for Sewage Systems. Additional provisions have been added to the Tennessee Design Criteria in order to include items not currently addressed in the Division of Water Pollution Control Standards.

These regulations apply to all wastewater systems developed in Williamson County that utilize land as a treatment system or disposal system for the wastewater. Wastewater systems covered under these regulations will be required to have a Tennessee State operating permit for the wastewater system. It is not intended that these regulations will apply to facilities whose only disposal point is discharged to a receiving stream as permitted through the NPDES permitting system, nor is it intended for these regulations to apply to on-site septic systems utilizing land disposal to serve single residential lots, or non-residential lots.

## 1.2 AUTHORITY

The Williamson County Water and Wastewater Treatment Authority is authorized to adopt by majority vote of the board, regulations, including requirements for the posting of performance bonds and maintenance bonds, governing the operation and maintenance of nontraditional sewage disposal systems that serve more than one (1) household. Such regulations shall be consistent with or more stringent than the Water Quality Control Act, compiled in Tennessee Code Annotated, title 69, chapter 3, part 1. Such regulations adopted pursuant to the Water Quality Control Act shall be approved in writing by the commissioner of environment and conservation. As used in these regulations, the phrase 'nontraditional sewage disposal systems' does not include subsurface sewage disposal systems that are subject to the permitting requirements of Tennessee Code Annotated, title 68, chapter 221, part 4, nor to wastewater collection and disposal systems that are owned or operated by a governmental entity. Such authority is expressly granted in Tennessee Code Annotated Section 68-221-607(16) (1999).

## 1.3 JURISDICTION

1. These wastewater disposal regulations of Williamson County shall govern all subdivisions of land within unincorporated Williamson County and the Town of Thompson Station.

2. No building permit or certificate of occupancy shall be issued for any parcel or plat of land which was created by subdivision after the effective date of, and not in conformity, with the provisions of these wastewater treatment and land disposal regulations and no construction of any private or public improvement shall take place or be commenced except in conformity with these regulations.

3. In the event that a subdivision or parcel containing any part of a wastewater treatment and land disposal system to which these regulations apply are annexed by a municipality, following the effective date of such annexation, the Williamson County Water and Wastewater Authority shall continue administration of the bonds. Release of any bonds shall only occur upon concurrence of both the municipality and Williamson County.

## 1.4 POLICY

1. The existing and proposed public improvements shall conform to and be properly related to the proposals shown in the Comprehensive Plan, Official Map, and the Capital Budget and programs of the county, and it is intended that these regulations shall supplement and facilitate the enforcement of the provisions and standards contained in the Zoning Resolution, Comprehensive Plan Official Map, and Land Use Plan, Subdivision Regulations and Capital Budget and programs of Williamson County.

## 1.5 ENACTMENT

In order that wastewater treatment and disposal systems may be created in accordance with these purposes and policies, these regulations are hereby adopted.

## 1.6 INTERPRETATION, CONFLICT AND SEPARABILITY

1. In their interpretation and application, the provisions of these regulations shall be held to be the minimum requirements for promotion of the public health, safety and general welfare.

2. It is established that these regulations are not intended to interfere with, abrogate or annul any regulations, statutes or laws. In any case where these regulations impose restrictions different from those imposed by any other provision of these regulations, or any other regulation, law or statute, whichever provisions are more restrictive or impose higher standards shall control.

3. If any part or provision of these regulations or application thereof is adjudged invalid by any court of competent jurisdiction, such judgment shall be confined in its operation to the part, provision or application directly involved in all controversy in which such judgment was rendered. The remainder of these regulations shall be considered valid and in force.

## 1.7 SAVING PROVISIONS

1. These regulations shall not be construed as altering, modifying, vacating or nullifying any rights or obligations obtained by any person, firm or corporation by lawful action of the county as of the date of adoption of these regulations or any amendment hereto.

2. Expansion of a System Previously Approved by the Williamson County Water and Wastewater Authority and/or Williamson County Regional Planning Commission:

2.1 In the event a Wastewater Treatment and Land Disposal System is contained on an approved plat recorded in the Williamson County Register of Deeds office on the date that the amendment of these regulations become effective, then the Wastewater Treatment and Land Disposal System may expand up to five percent (5%) of the system's approved average daily flow of the Treatment and/or Disposal area by submitting a revised DDR, DSIR and revised construction plans and specifications for the increased capacity, along with the required fees and in accordance with these Regulations, for review and approval, without revising and re-recording the final plat.

2.2 In the event a Wastewater Treatment and Land Disposal System is contained on an approved plat recorded in the Williamson County Register of Deeds office on the date that the amendment of these regulations become effective, then the Wastewater Treatment and Land Disposal System may expand more than five percent (5%) of the system's approved average daily flow by resubmitting the following, so long as an amendment to the final plat is not required as a result of the expansion:

a. Modifications necessary to the DDR, DSIR and the construction plans to provide the desired treatment capacity.

b. Identification of planned service area that will be covered by the proposed expansion.

c. Any required fees.

d. The resubmittals provided in accordance with this 2.2 must be in conformity with the regulations effective at the time of such resubmittal.

2.3 In the event a Wastewater Treatment and Land Disposal System is contained on an approved plat recorded in the Williamson County Register of Deeds office on the date that the amendment of these regulations become effective, then the Wastewater Treatment and Land Disposal System may expand more than five percent (5%) of the system's approved average daily flow by resubmitting the following and resubmitting all information necessary to revise the plat where the expansion requires a plat revision:

a. Modifications necessary to the DDR, DSIR and the construction plans to provide the desired treatment capacity.

b. Identification of planned service area that will be covered by the proposed expansion.

c. Any required fees.

d. The resubmittals provided in accordance with this 2.3 must be in conformity with the regulations effective at the time of such resubmittal.

e. Information required for any subdivision or non-residential use along with the required DDR and DSIR and the appropriate fees as if there was never an approval and the existing recorded plat becomes null and void.

2.4 In the event a Wastewater Treatment and Land Disposal System is contained on a plat not recorded in the Williamson County Register of Deeds office, then the Wastewater Treatment and Land Disposal System may be amended to reflect any expansion by resubmitting the information required for any subdivision or non-residential use along with the required DDR and DSIR and the appropriate fees as if there was never an approval.

## 1.8 DEFINITIONS

1. For the purpose of these regulations, certain numbers, abbreviations, terms, and words used herein shall be used, interpreted, and defined as set forth in this section. Where words within these regulations have not been defined, the standard dictionary definition shall prevail.

2. Unless the context clearly indicates to the contrary, words used in the present tense include the future tense; and words in the plural include the singular.

2.1 Words and Terms Defined:

Agent, Applicant, Developer, Subdivider - The owner of land proposed to be subdivided or his representative. One who, having an interest in land, causes it, directly or indirectly, to be divided into a subdivision. Consent shall be required from the legal owner of the premises.

Auxiliary Disposal Site - The auxiliary disposal sites are land or parcels that may be used for effluent disposal and may have other uses. Higher levels of treatment are required for auxiliary disposal sites. These sites shall provide opportunities for beneficial reuse of the treated effluent.

Back-up Wastewater Disposal Site - Back-up wastewater disposal sites or secondary disposal site is the back-up land or parcels used to provide a redundant wastewater disposal site, in the event the primary wastewater disposal site does not provide proper or adequate wastewater disposal. The back-up wastewater disposal site shall be established in the initial approval process and shall be owned by the wastewater treatment system.

Buffer Zone - Minimum distance from the wetted "disposal field" site area to a property line, habitable structure, water well, right-of-way line, water course or other location.

Easement - Authorization by a property owner for the use by another, and for a specified purpose, of any designated part of his property.

Effluent - The treated wastewater discharged from a wastewater treatment system and applied to the disposal site(s).

Final Plat - Map or plan of record of a subdivision and any accompanying material, as described in subdivision regulations.

Lot - A parcel of land that:

a. is undivided by any street or private road;

b. is occupied by or designated to be developed for buildings or principal uses which must meet all zoning and subdivision requirements of these regulations and the Williamson County Zoning Ordinance;

c. contains the accessory buildings or uses customarily incidental to such building, use, or development, including such open spaces and yards as are designed and arranged or required by the Zoning Ordinance for such building, use, or development.

Non-Traditional Sewage Disposal Systems - As used in these regulations, the phrase 'non-traditional sewage disposal systems' does not include subsurface sewage disposal systems that are subject to the permitting requirements of Tennessee Code

Annotated, title 68, chapter 221, part 4, nor to wastewater collection and disposal systems that are owned or operated by a governmental entity.

Owner - Any person, group of persons, firm or firms, corporation or corporations, or any other legal entity, excluding homeowners associations or other trust indenture, having legal title to or sufficient proprietary interest in the wastewater treatment and disposal systems described in the regulations. Said Owner shall be required to employ on a full-time basis a person to hold a valid, current and applicable license issued by TDEC, Water & Wastewater Operators Certification Board. Said Owner shall also be required to hold a valid and current approval from the Tennessee Regulatory Authority to operate said system in the proposed location.

Preliminary Plat - The preliminary drawing or drawings, described in these regulations, indicating the manner or layout of the subdivision to be submitted to the Planning Commission for approval.

Sketch Plan - A generalized concept plan of subdivision offering information in regard to proposed improvements and natural features of the property in question prepared prior to preliminary plat to save time and expense in reaching general agreement as to the form of the plat and the objectives of these regulations.

Slope - The deviation of the land surface from the horizontal per unit horizontal distance changed, generally expressed in per cent, i.e. vertical rise or fall per foot dividing the horizontal distance between contour lines into the vertical interval of the contours as required by the appropriate regulations.

State of Tennessee Operating Permit - Permit issued by TDEC granting approval and authority for the operation of a wastewater treatment and disposal system within the State of Tennessee.

Tennessee Department of Environment and Conservation (TDEC) - Tennessee governmental agency responsible for regulatory compliance with environmental regulations, formerly, the Tennessee Department of Health and Environment (TDHE). TDEC and TDHE may be used interchangeably.

Utility - Any construction of public roads, public water, public drainage, public sanitary facilities, or any other improvement that is or will be dedicated to public use.

Wastewater Disposal Site - The primary land or parcel used for the land disposal of the effluent. The wastewater disposal site or sites shall be restricted in their usage to only effluent disposal.

Wastewater Treatment System - The wastewater system used to collect, treat and store the wastewater. The system include all components such as collector lines, septic tanks, pump stations, treatment unit, storage ponds, disposal site and back-up disposal site.

## 1.9 SUBMITTAL AND REVIEW PROCESS

1. The Williamson County Water and Wastewater Authority, by the adoption of these Regulations, formally delegate the administration, implementation and review of these Regulations and the wastewater treatment and land disposal systems subject to these Regulations to the Williamson County Regional Planning Commission and its staff in accordance with Tennessee Code Annotated Section 68-221-607(12) (1999).

2. Review and approval of the wastewater treatment and disposal systems will be required from both the Tennessee Department of Environment and Conservation and the Williamson County Planning Department. It is anticipated that this review and approval process will be accomplished on a concurrent basis. However, the Williamson County Planning staff will not approve the wastewater treatment and disposal systems until such time as the Tennessee Department of Environment and Conservation has completed their review and issued an approval letter and an operating permit for the facility. In addition to the requirements of the Tennessee Department of Environment and Conservation, the Williamson County Planning staff will also review the wastewater system on the basis of these additional criteria or regulations enacted by Williamson County.

3. In conjunction with the sketch plan or preliminary site plan (non-residential) review process, the Owner (Applicant), or his authorized agent, shall submit to TDEC and Williamson County a Design Development Report (DDR) and Detailed Soil Investigation Report (DSIR) as outlined in Tables 1.9 and 1.9.1, respectively. The DDR and DSIR shall be submitted for review in conjunction with sketch plan or preliminary site plan (non-residential) submission. Along with the DDR and DSIR, the Owner and/or the Agent, Applicant, Developer, Subdivider shall provide written proof from the Tennessee Regulatory Authority of a valid and current Certificate of Convenience and Necessity issued to and in the name of the proposed Owner for the area to be served, written proof from the Tennessee Secretary of State's office of valid legal existence of the Owner and the Agent, Applicant, Developer, and Subdivider in good standing with the Tennessee Secretary of State's office and written proof that the person or entity contracted to install the proposed system has a valid and current contractor's license by the applicable licensing board of the State of Tennessee with the proper designation for the type of system proposed in conjunction with sketch plan or preliminary site plan

(non-residential) submission. A filing fee of $1,500 shall accompany the submission to Williamson County.

It is the desire of the Williamson County Water and Wastewater Authority that all of the wastewater treatment and land disposal systems proposed in accordance with these Regulations be evaluated in the Design/Development Report with the feasibility of providing an area-wide or centralized wastewater treatment and disposal system for a designated service area. In addition to the requirements outlined in Tables 1.9 and 1.9.1., the Design/Development Report shall include an evaluation of the potential wastewater service area that could be created to provide wastewater treatment and disposal based on both current and future demand. The evaluation should include a drainage basin assessment and determination of the potential wastewater treatment and disposal service area for a proposed system.

The centralized treatment system evaluation shall identify adjoining properties that may have a potential for receiving wastewater treatment and disposal services from this project. The Design/Development Report shall identify the specific service areas for the centralized wastewater treatment system and provide an evaluation of the opportunities to provide wastewater treatment and disposal for the entire service area.

The evaluation of the centralized wastewater treatment and disposal project for a designated service area will be reviewed and evaluated by the Williamson County Water and Wastewater Authority to determine the feasibility and probability of a centralized wastewater treatment system being provided for the designated service area. In the event the Williamson County Water and Wastewater Authority determines that a centralized wastewater treatment and disposal system is appropriate for the designated service area, the Owner will be required to design the wastewater treatment disposal system in such a way that the facility can readily be expanded to accommodate the identified service area of the centralized wastewater treatment and disposal system.

4. Approval of the DDR and DSIR by TDEC and Williamson County will be required in conjunction with preliminary plat approval or final site plan approval.

5. The construction plans and specifications for the wastewater treatment and disposal system shall be submitted to and approved by TDEC and Williamson County. Approval of the construction plans and specifications by TDEC and Williamson County will be required prior to approval of final plat or site plan by Williamson County. A filing fee of $2,000 shall accompany the submission of the plans and specifications to Williamson County.

6. The construction of the wastewater treatment and disposal system shall be completed and approved by TDEC, an operating permit must be issued by TDEC, and the design engineering shall submit certification that the wastewater treatment and disposal system was constructed in accordance with approved construction plans and

specifications, prior to the submittal of the final plat to the Williamson County Regional Planning Commission for consideration.

7. Operational reports shall be submitted to TDEC and Williamson County Planning Department on a quarterly basis for compliance review.

**Table 1.9**
**DESIGN DEVELOPMENT REPORT**
**REQUIRED INFORMATION**

1.0 Site Description:

- 1.1 Location map
- 1.2 Climate
- 1.3 Geology (including subsurface hydrology)
- 1.4 Topography
- 1.5 Access
- 1.6 Water supply wells within 1,500 L.F. of facility
- 1.7 Centralized Wastewater Treatment/Disposal (CWTD) Evaluation
  - a. Identify potential CWTD service area (topographic maps of area adjacent to proposed project).
  - b. Evaluation of the Facility for providing a CWTD system in the service area. (Nature and extent of the area to be served, including immediate and probable future development).
  - c. Summary, conclusion and plan of service regarding the potential CWTD systems within the identified service area.

2.0 Scaled drawing with 2 foot elevation contours showing the preliminary site layout including:

- 2.1 Pre-application treatment facilities
- 2.2 Storage facilities
- 2.3 Disposal fields
- 2.4 Buffer zones
- 2.5 Hand auger, test pit and soil boring locations
- 2.6 Access roads and utilities
- 2.7 Watercourses
- 2.8 Drainage structures
- 2.9 Flood elevations with 10 year, 50 year, and 100 year flood plain elevation noted
- 2.10 Residences and habitable structures within or adjacent to site
- 2.11 Wells within 500 ft. of the site

3.0 Design wastewater characteristics (influent to pre-application treatment and treated effluent to disposal fields). If the project involves an existing facility, then actual, recent data should be used:

- 3.1 Average and peak daily flows
- 3.2 Biochemical Oxygen Demand

3.3 Total Suspended Solids
3.4 Ammonia Nitrogen, Total Kjeldahl Nitrogen, Nitrate plus Nitrite
3.5 Total Phosphorus
3.6 Chloride
3.7 Sodium Adsorption Ratio
3.8 Electrical Conductivity
3.9 Metals/Priority Pollutants

4.0 Water Balance/determination of design wastewater loading rates for each disposal field

5.0 Nitrogen Balance/selection of cover crop and management scheme

6.0 Background groundwater samples

7.0 Phosphorus and other constituent loading rates

8.0 Determination of wetted field area(s) and required storage volume

9.0 Process design for pre-application treatment facility

9.1 Schematic of pump stations and unit processes.
9.2 Basin volumes, loading rates, hydraulic detention times, etc. (aerobic or anaerobic).
9.3 Capacity of all pumps, blowers and other mechanical equipment. Pump curves and hydraulic calculations for the distribution system must accompany the DDR.
9.4 Design life of treatment and disposal system

10.0 Detailed Soil Investigation Report (reference Table 1.9.1)

11.0 The back-up wastewater disposal site(s) shall be identified and shown in the DDR. All proposed uses for the back-up site(s) shall be described in the DDR.

12.0 Detailed construction cost estimate for the wastewater treatment and disposal system. Cost estimate shall include all components required for proper operation of system, i.e., septic tanks, collection lines, treatment systems, land cost, disposal site costs, etc.

13.0 Description of the "back-up" system proposed in accordance with regulations. Cost estimate for back-up system shall include all required components and modifications to existing system, sewer connection fees to public sewer system, additional land and/or system costs.

14.0 If auxiliary disposal sites are anticipated beyond the primary dedicated disposal site, these sites or disposal options must be presented for review. Beneficial reuse opportunities with treated wastewater will be considered on a case-by-case basis.

**Table 1.9.1**
**DETAILED SOIL INVESTIGATION REPORT**
**REQUIRED INFORMATION**

1.0 Site Description:

- 1.1 Location map
- 1.2 Topographic map
- 1.3 Soil Survey map (see Note 1)
- 1.4 Hand auger, test pit and soil boring locations

2.0 Soil series descriptions (each soil series present)

- 2.1 Texture
- 2.2 Permeability
- 2.3 Slope
- 2.4 Drainage
- 2.5 Depth to seasonal high water table
- 2.6 Depth to bedrock
- 2.7 Erodibility

3.0 Soil characteristics (each soil series present)

- 3.1 Hand auger, test pit and soil boring logs:
  - 3.1.1 Soil horizons
  - 3.1.2 Depth to groundwater
  - 3.1.3 Depth to rock
- 3.2 Unified Soil Classification
- 3.3 Results from saturated hydraulic conductivity testing
- 3.4 Results from soil chemistry testing:
  - 3.4.1 pH
  - 3.4.2 Cation Exchange Capacity
  - 3.4.3 Percent Base Saturation
  - 3.4.4 Sodium Exchange Potential
  - 3.4.5 Phosphorus Absorption
  - 3.4.6 Nutrients (N, P, K)
  - 3.4.7 Agronomic trace elements (for cover crop proposed)

3.4.8 Mineralogy (clay)

3.5 Engineering properties of soils proposed for any potential pond construction.

3.5.1 Clay content
3.5.2 Permeability
3.5.3 Plasticity
3.5.4 Consistency

4.0 Identification of subsurface conditions adversely affecting vertical or lateral drainage of the land treatment site.

5.0 Delineation of soils and areas suitable and not suitable for wastewater drip or spray irrigation.

6.0 Determination of design percolation for each soil type.

NOTE 1: Soil Survey Maps shall be in accordance with the following requirements for an Extra High Intensity Soil Map

Extra High-Intensity Soil Maps

These are special use maps that show a high degree of soil map unit and landscape configuration detail. Each highly detailed soil map unit will be accompanied by site specific interpretations and recommendations (i.e. specific soil improvement practices). This type of map is to provide the information needed, relative to soil characteristics and landscape features, so that Williamson County is able to thoroughly evaluate a site and ascertain its suitability to support effluent disposal systems.

The base map shall be at a scale of 1:1200 or 1 inch equals 100 feet. The soil mapping grid stakes are to be set at intervals of 50 feet. Areas of 1000 square feet or more with a significant difference from the adjoining soil mapping units shall be delineated.

Soil line placement shall have a tolerance limit of 10 feet. With the available ground control, there should be no less than 41 soil observations per acre. Soil Observations should be made at each grid stake and the grid-box center. Any mappable landscape feature shall be located with absolute accuracy (i.e. drainways, embankments, field roads, wells, etc.).

These maps shall be clearly marked and labeled, in a conspicuous manner, as an *EXTRA HIGH-INTENSITY SOIL MAP*.

Williamson County will require ULTRA-HIGH-INTENSITY SOIL MAPPING if the sites have been disturbed (i.e. cut, filled, compacted, etc.) or sites that have been previously assessed and were found to be unsuitable soil conditions.

## 1.10 ASSURANCE FOR COMPLETION AND OPERATION OF IMPROVEMENTS (BONDING REQUIRMENTS)

It is the intention of these regulations that a performance bond be required for all projects utilizing an non-traditional wastewater treatment and disposal system, utilizing land as the disposal location for the wastewater. The bond shall be equal to 150% of the cost for the wastewater treatment and disposal system. This bond shall include the cost of all the facilities, land, and improvements to the land in order to build the wastewater treatment and land disposal system. The construction cost for all of the components of the wastewater collection, treatment and disposal system shall be included in the performance bond. This bond shall be in place for a minimum period of three (3) years after 80% build-out of the development or project.

Agent, Applicant, Developer shall be required to execute a performance agreement consistent with and in accordance with these regulations for the provision of the wastewater treatment and disposal system and maintenance which shall be in a form acceptable to the Authority and binding upon all heirs, successors, and assigns of Agent, Applicant and Developer. Such agreement shall be executed prior to final plat approval in the case of residential developments, and final site plan approval in the case of non-residential developments.

Due to the relatively unproven reliability of land disposal systems within Williamson County, a "back-up" system or redundant wastewater treatment and disposal system must also be identified and bonded. The back-up or redundant system shall include one of the following:

1. Commitment from existing publicly owned treatment works (POTW) owned and operated by a public municipal utility to accept the wastewater from the wastewater treatment and disposal system in the event of failure or unacceptable operation of the wastewater treatment and disposal system which creates a public health and safety concern or;

2. Provide "back-up" facilities that will duplicate the wastewater treatment and disposal system proposed. This will include all the additional treatment and land disposal systems necessary to provide 100% redundancy to the wastewater treatment and disposal system proposed.

A “back-up” system performance bond equal to 150% of the cost for the redundant system or the cost for connection to the publicly owned treatment works will be provided. This performance bond shall provide sufficient money for all required modifications to the treatment system so the wastewater can be discharged to a publicly owned treatment works (including new sewer facilities and POTW connection fees), or a new treatment and disposal system can be constructed.

The “back-up” system performance bonds shall be in place for the anticipated design life of the wastewater treatment system but in no case shall the performance bond period be less than ten (10) years from 80% build-out of the development.

Applicable provisions of Section IV, “ASSURANCE FOR COMPLETION AND MAINTENANCE OF IMPROVEMENTS”, of the Williamson County Subdivision Regulations, concerning the type of acceptable performance bonds and Williamson County Planning Commission’s rights under the required bonds are incorporated herein and are made part of these regulations.

### 1.11 OWNERSHIP OF WASTEWATER TREATMENT AND DISPOSAL SYSTEM SITE

1. The wastewater treatment system, storage lagoons and land disposal site(s) and back-up disposal sites shall be owned and operated by the same entity. No homeowners association of trust indenture shall be permitted to own or operate any part of any wastewater treatment and disposal system. The Owner of the wastewater treatment and disposal system shall also be required to employ on a full-time basis a person to hold a valid, current and applicable operators license issued by TDEC, Water & Wastewater Operators Certification Board. Said Owner shall also be required to hold a valid and current approval from the Tennessee Regulatory Authority to operate said system in the proposed location. The treatment system and disposal site shall be dedicated or restricted so the only approved or acceptable use for the land disposal sites shall be for the purpose of providing wastewater treatment and disposal. The use of the land disposal sites as open space in the base site area calculations for subdivisions is prohibited. All of the components of the wastewater system, including the wastewater septic tanks, if required, collection systems, pumping stations, treatment systems and storage lagoons land disposal sites shall be owned and operated by the same entity.

2. All required wastewater utility easements shall be shown on plat or site plan. Easements shall be provided to allow access to all components of the treatment system, i.e., septic tanks, pipelines, etc.

3. If auxiliary disposal sites are proposed (over and above the minimum area required for satisfactory operation of the treatment and disposal system), these sites will

not be required to be owned by the same entity as the wastewater treatment and disposal system. A written contract or agreement between the owner of the treatment system and the owner of the auxiliary disposal site will be required. The contract will require the owner of the auxiliary disposal site to adhere to all conditions and requirements placed on the use of the auxiliary disposal sites by TDEC and/or Williamson County.

### 1.12 AMENDMENTS

These Regulations may be amended as the public health, safety and general welfare require and in accordance with Tennessee Code Annotated Section 68-221-607(16) (1999).

## SECTION 2.0 - REQUIREMENTS FOR WASTEWATER SYSTEMS

### 2.1 GENERAL

These requirements shall apply to all wastewater treatment and disposal systems utilizing land application as a disposal method for the wastewater. These regulations do not apply to single residential or non-residential lots utilizing on-site septic tanks for their treatment and disposal of wastewater.

All wastewater treatment and disposal systems constructed in Williamson County using land for the disposal of the wastewater shall comply with the provisions of the State of Tennessee, Department of Environment and Conservation, Division of Water Pollution Control, Design Criteria for Sewage Works, Chapter 16, Slow Rate Land Treatment, effective April 2, 1996. The provisions of Chapter 16 shall apply unless amended or modified herein.

## 2.2 SLOW RATE LAND TREATMENT

**STATE OF TENNESSEE**
**DEPARTMENT OF ENVIRONMENT AND CONSERVATION**
**DIVISION OF WATER POLLUTION CONTROL**
**DESIGN CRITERIA FOR SEWAGE WORKS**
**SLOW RATE LAND TREATMENT**
**CHAPTER 16**
**(April 2, 1996)**

16.13 Plan of Operation and Management



Appendix 16-A

## SLOW RATE LAND TREATMENT

16.1 General

16.1.1 General

This chapter provides guidelines and criteria for the design of slow rate land treatment systems. It is not applicable to overland flow or rapid infiltration.

There are basically two types of slow rate systems. Type 1 systems are designed to apply the maximum amount of wastewater to the minimum amount of land area. The wastewater loading rate is limited by the maximum amount of a particular wastewater constituent that can be applied to a specific site. For wastewater from municipalities, the limiting design factor is usually either the hydraulic capacity of the soil or the nitrogen content of the wastewater. For industrial wastewater, the limiting design factor may be the hydraulic capacity of the soil, nitrogen or any other wastewater constituent such as metals, organics, etc. Type 2 systems are designed to apply the available wastewater to the maximum land area possible. The objective is usually crop irrigation and the design involves determining the water needs of the particular crop.

Although this chapter is written around Type 1 systems, the methodology can be adapted to satisfy Type 2 systems.

16.1.2 Applicability

Slow rate systems are designed and operated so that there is no direct discharge to surface waters. Disposal is by evaporation directly to the atmosphere, by transpiration to the atmosphere via vegetation uptake and by percolation to groundwater. A State of Tennessee Operating Permit is required for operation of slow rate land treatment systems.

16.1.3 Location

The disposal site should generally be relatively isolated, easily accessible and not susceptible to flooding. The site can be developed on agricultural land and/or forests or can include parks, golf courses, etc. Site location shall take into account dwellings, roads, streams, etc. A site approval by the Division will be required before review of the Engineering Report.

16.1.4 Topography

Maximum grades for wastewater spray fields should be limited to 8% for row crops, 15% for forage crops and 30% for forests. The maximum grade for any surface spreading system should be 10%. Ideally, any site should have a minimum slope of 2 - 3%. Sloping sites promote lateral subsurface drainage and make ponding and extended saturation of the soil less likely than on level sites. Depressions, sink holes, etc., are to be avoided.

16.1.5 Soils

In general, soils with a USDA Soil Conservation Service permeability classification of moderately slow (0.2 to 0.6 inches/hour) or more are suitable for wastewater irrigation. However, groundwater and drainage conditions must also be suitable. Soils which are poorly drained, have high groundwater tables or restrictive subsurface soil layers are not suitable for slow rate land treatment without drainage improvements.

16.2 Soil Investigations

16.2.1 General

The land treatment soil investigation must characterize the infiltration rate, permeability, and chemical properties of the first 5 to 10 feet of the soil profile. It must verify Soil Conservation Service soil mapping. It must also determine the elevation of the seasonal high groundwater, establish the groundwater flow direction and gradient, and identify any subsurface conditions which may limit the vertical or lateral drainage of the land treatment site. The number of soil samples necessary to supply all of this information will be dependent on the nature of the particular site. As a minimum, however, TDHE recommends that at least one sample be taken for every acre in order to develop a detailed soils map of the site for the Engineering Report. Samples from soils with similar characteristics can be combined and the analyses can be performed on each soil group sample.

16.2.2 Saturated Hydraulic Conductivity Testing

Saturated vertical hydraulic conductivity testing is required for the most limiting horizon of each soil series present. The most limiting soil horizon should be determined from soil survey information. A minimum of three (3) tests for each soil series should be performed, unless the flooding basin method is used, in which case, only one test per series is needed. Testing for saturated horizontal hydraulic conductivity is additionally required when subsurface drainage systems are planned or when lateral subsurface drainage is the predominant drainage mechanism for the land treatment site.

Acceptable methods for saturated hydraulic conductivity testing are listed in Table 16-1. Percolation tests as performed for septic tank drain fields are not acceptable.

16.2.3 Soil Chemical Testing

The pH, Cation Exchange Capacity, and Percent Base Saturation, of each soil series must be determined from samples taken from the A and B horizons. These chemical tests determine the retention of wastewater constituents in the soil and the suitability of the soil for different cover crops. A minimum of three (3) samples for each soil series should be taken. The samples can be mixed together and tested for each soil series if the series is uniform. Testing for soil nutrients (nitrogen, phosphorus and potassium) and agronomic trace elements may be included if appropriate for the vegetative management scheme.

Soil chemical testing should be in accordance with the latest edition of Methods of Soil Analysis published by the American Society of Agronomy, Madison, Wisconsin.

16.3 Pre-application Treatment Requirements

16.3.1 General

Wastewater irrigation systems have a demonstrated ability to treat high strength organic wastes to low levels. However, such systems require a high degree of management with particular attention paid to organic loading rates and aeration of the soil profile between wastewater applications.

The TDHE requires that all domestic and municipal wastewaters receive biological treatment prior to irrigation. This is necessary to:

a. Protect the health of persons contacting the irrigated wastewater.

b. Reduce the potential for odors in storage and irrigation.

Some industrial wastewaters may be suitable for direct land treatment by irrigation under intensive management schemes. The TDHE will evaluate such systems on a case-by-case basis.

16.3.2 BOD and TSS Reduction, and Disinfection

Pre-application treatment standards for domestic and municipal wastewaters prior to storage and/or irrigation are as follows:

a. Sites Closed to Public Access

All wastewater must be treated to a level afforded by lagoons which are designed in accordance with chapter 9.

Disinfection is generally not required for restricted access land treatment sites. The TDHE may, however, require disinfection when deemed necessary.

b. Sites Open to Public Access

Sites open to public access include golf courses, cemeteries, green areas, parks, and other public or private land where public use occurs or is expected to occur. Wastewater irrigated on public access sites must not exceed a 5-day Biochemical Oxygen Demand and Total Suspended Solids of 30 mg/l, as a monthly average. Disinfection to reduce fecal coliform bacteria to 200 colonies/100 ml is required.

The pre-application treatment standards for wastewater that is to be applied to public access areas will be reviewed by the TDHE on a case-by-case basis. More stringent pre-application treatment standards may be required as the TDHE deems necessary. TDHE recommends that the engineer give preference to pretreatment systems that will provide the greatest degree of reliability.

16.3.3 Nitrogen

Maximum nitrogen removal occurs when nitrogen is applied in the ammonia or organic form. Nitrate is not retained by the soil and leaches to the groundwater, especially during periods of dormant plant growth. Therefore, the pre-application treatment system must not produce a nitrified effluent.

The TDHE recommends that aerated or facultative wastewater stabilization ponds be used for pre-application treatment where possible. These systems generally produce a poorly nitrified effluent well-suited for wastewater irrigation. When mechanical plants are employed for pre-application treatment, they should be designed and operated to limit nitrification.

The Engineering Report should indicate the expected range of nitrogen removal in the pre-application treatment system. Predictive equations for nitrogen removal in facultative wastewater stabilization ponds have been developed by Pano and Middlebrooks (1982), and Reed (1985).

16.3.4 Treatment and Storage Ponds

The storage pond and irrigation pump station must be hydraulically separate from the treatment cells (i.e., pumping must not affect hydraulic detention time in these cells). The TDHE recommends the use of Chapter 9 of the Design Criteria for Sewage Works, as well as the United States Environmental Protection Agency's October 1983 Design Manual: Municipal Wastewater Stabilization Ponds as a reference for design of pre-application treatment ponds.

## 16.4 Inorganic Constituents of Treated Wastewater

Inorganic constituents of effluent from pre-application treatment should be compared with Table 16-2 to insure compatibility with land treatment site soils and cover crops.

## 16.5 Protection of Irrigation Equipment

Prior to pumping to the spray field distribution system, the wastewater must be screened to remove fibers, coarse solids, oil and grease which might clog distribution pipes or spray nozzles. As a minimum, screens with a nominal diameter smaller than the smallest flow opening in the distribution system should be provided. Screening to remove solids greater than one third (1/3) the diameter of the smallest sprinkler nozzle is recommended by some sprinkler manufacturers. The planned method for disposal of the screenings must be provided.

Pressurized, clean water for backwashing screens should be provided. This backwash may be manual or automated. Backwashed screenings should be captured and removed for disposal. These screenings should not be returned to the storage pond(s) or pre-application treatment system.

## 16.6 Determination of Design Percolation Rates

### 16.6.1 General

One of the first steps in the design of a slow rate land treatment system is to develop a "design percolation rate" (Perc). This value is used in water balance calculations to determine design wastewater loading(s) and, thus, spray field area requirements. The percolation rate is a function of soil permeability and drainage.

### 16.6.2 Design Values

The most limiting layer; i.e., A, B or C horizon, of each soil series must be identified. Any surface conditions which limit the vertical or lateral drainage of the soil profile must also be identified. Examples of such conditions are shallow bedrock, a high water table, aquitards, and extremely anisotropic soil permeability.

Values of saturated vertical hydraulic conductivity from soil testing are used to develop the design percolation rate.

Values of saturated vertical hydraulic conductivity must be modified by an appropriate safety factor to determine design percolation. The safety factor reflects the influence of several elements including: the fact that long periods of saturation are undesirable, the uncertainty of test values, the drainage characteristics of the land treatment site, the variation of permeability within and between different soil series, the rooting habits of the vegetation, the soil reaeration factors, and the long-term changes in soil permeability due to wastewater application. The TDHE recommends that the design percolation rate of land treatment sites be no more than 10 percent of the mean saturated vertical hydraulic conductivity of the most limiting layer within the first five feet from the surface, in accordance with the following equation:

$$\text{Perc} = K \times 0.10 \qquad \text{Eq. 16-1}$$

Where, Perc = Design percolation rate, (in/month)

K = Permeability of limiting soil layer, (in/month)

0.10 = Safety factor

Sites with seasonal high groundwater less than 5 feet deep may require drainage improvements before they can be utilized for slow rate land treatment. The design percolation at such sites is a function of the design of the drainage system.

## 16.7 Determination of Design Wastewater Loading

### 16.7.1 General

The design wastewater loading is a function of:

a. Precipitation.
b. Evapotranspiration.
c. Design percolation rate.
d. Nitrogen loading limitations.
e. Other constituent loading limitations.
f. Groundwater and drainage conditions.
g. Average and peak design wastewater flows.

Therefore, developing the design wastewater loading is an iterative process. An initial value is selected from water balance calculations and used to determine wetted field area. This loading is then compared to nitrogen and other constituent loading limitations (reference Section 16.8). If the initial value exceeds these limitations, the design wastewater loading is reduced and the process is repeated. This iterative process is illustrated in Appendix 16-A.

16.7.2 Water Balance

Maximum allowable monthly wastewater hydraulic loadings are determined from the following water balance equation:

$$Lwh = (PET + Perc) - Pr \qquad \text{Eq. 16-2}$$

Where, Lwh = Maximum allowable hydraulic wastewater loading (in/month).

PET = Potential Evapotranspiration, (in/month)

Perc = Design percolation rate (in/month);

Pr = Five-year return monthly precipitation, (in/month).

Example water balance calculations are presented in Appendix A. From these, critical water balance months; i.e., months with the smallest allowable hydraulic wastewater loading, are identified.

16.7.3 Potential Evapotranspiration (PET)

Reliable field data for evapotranspiration are difficult to obtain. Therefore, values for average monthly potential evapotranspiration (PET) generated from vegetative, soil and climatological data are used in water balance calculations. The method used to estimate average monthly potential evapotranspiration for water balance calculations <u>must</u> be referenced in the Engineering Report. In addition, these values must be based on a record of 30 years of historical climatic data.

The Thornthwaite method is an empirical equation developed from correlations of mean monthly air temperatures with evapotranspiration from water balance studies in valleys of the east-central United States where soil moisture conditions do not limit evapotranspiration (The Irrigation Association, 1983, pp. 112 to 114). The Thornthwaite method is applicable to slow rate land treatment systems in the southeast United States, including Tennessee.

A modified version of the Thornthwaite equation is outlined below. Note that the results are expressed in inches, for a month period. Finally, for water balance calculations as described in this Section, a 30-year record of historical climatic data (referred to as the climatological normal) is required to determine monthly temperature normals used in the Thornthwaite equation.

$$PET = 0.63 \times S \times [\underline{(50 \times T-32)/(9xI)}]^{A} \qquad \text{Eq. 16-3}$$

Where, PET = 30-day Thornthwaite Potential Evapotranspiration,(in)

S = Daylight hours, in units of 12 hours

T = Mean (normal) monthly air temperature, in degrees Fahrenheit

I = Annual heat index obtained by summing the 12 monthly heat indexes, i, where:

$$i = \underline{(T-32/9)}^{1.514}$$

A = Power term derived from annual heat index, I, where:

$$A = 0.000000675(I)^3 - 0.0000771(I)^2 + 0.01792(I) + 0.49239$$

Climatic information more appropriate to any specific location in Tennessee can be used, but its use must be documented in the Design Report. Also, other methods of calculating the PET can be used, provided that the use of an alternative method has been given prior approval by the TDHE.

16.7.4 Five-Year Return Monthly Precipitation

The TDHE requires the use of five-year return, monthly precipitation values in calculating the water balance. These values can be determined by either of the following methods:

a. Use the five-year annual rainfall and apportion this amount to each month, using each month's average for a 30-year period.

b. $Pr = Pr(Ave) + (0.85 \times \text{std. dev.})$ Eq. 16-4

where Pr(Ave) = average monthly precipitation from a 30- year historic record

std. dev. = standard deviation for same

Thirty-year records of precipitation (as well as temperature) are available for specific locations in Tennessee as well as for the four geographic divisions, shown in Figure 16-1. Climatic information can be obtained from the National Oceanic and Atmospheric Administration (NOAA)in Asheville, North Carolina. The source of any data that are used in designing a slow-rate irrigation system must be referenced in the Design Report.

## 16.8 Nitrogen Loading and Crop Selection and Management

### 16.8.1 General

Nitrate concentration in percolate from wastewater irrigation systems must not exceed 10 mg/L. Percolate nitrate concentration is a function of nitrogen loading, cover crop, and management of vegetation and hydraulic loading. The design wastewater loading determined from water balance calculations must be checked against nitrogen loading limitations. If, for the selected cover crop and management scheme, the proposed wastewater loading results in estimated percolate nitrate concentrations exceeding 10 mg/l, either the loading must be reduced or a cover crop with a higher nitrogen uptake must be selected.

### 16.8.2 Nitrogen Loading

In some instances, the amount of wastewater that can be applied to a site may be limited by the amount of nitrogen in the wastewater. A particular site may be limited by the nitrogen content of the wastewater during certain months of the year and limited by the infiltration rate during the remainder of the year.

Equation 16-5 is used to calculate, on a monthly basis, the allowable hydraulic loading rate based on nitrogen limits:

$$Lwn = \frac{Cp\,(Pr-PET) + U(4.424)}{(1 - f)(Cn) - Cp} \qquad \text{Eq. 16-5}$$

Where: Lwn = allowable monthly hydraulic loading rate based on nitrogen limits, inches/month

Cp = nitrogen concentration in the percolating wastewater, mg/l. This will usually be 10mg/l

Pr = Five-year return monthly precipitation, inches/month

PET = potential evapotranspiration, inches/month

U = nitrogen uptake by crop, pounds/acre/month

Cn = nitrogen concentration in applied wastewater, mg/l (after losses in pre-application treatment)

f = fraction of applied nitrogen removed by denitrification and volatilization.

The values of Lwh and Lwn are compared for each month. The lesser of the two values, designated as Lwd, will be used in subsequent calculations to determine the amount of acreage needed.

The monthly values for nitrogen uptake by crops, U, can be derived by several methods:

1. Assume that the annual nitrogen uptake is distributed monthly in the same ratio as is the PET.

2. If data on nitrogen uptake versus time are available for the crops and climatic region specific to the project under design, then such information may be used.

Appendix A contains an example that illustrates the use of equations 16-2 and 16-5.

### 16.8.3 Cover Crop Selection and Management

Row crops may be irrigated with wastewater only when not intended for direct human consumption. Livestock must not be allowed on wet fields so that severe soil compaction and reduced soil infiltration rates can be avoided. Further, wet grazing conditions can also lead to animal hoof diseases. Pasture rotation should be practiced so that wastewater application can be commenced immediately after livestock has been removed. In general, a pasture area should not be grazed longer than 7 days. Typical regrowth periods between grazings range from 14 to 35 days. Depending on the period of regrowth provided, one to three water applications can be made during the regrowth period. At least 3 to 4 days drying time following an application should be allowed before livestock are returned to the pasture. Unmanaged, volunteer vegetation (i.e., weeds) is not an acceptable spray field cover. Disturbed areas in forest systems must be initially grassed and replanted for succession to forest.

Spray field cover crops require management and periodic harvesting to maintain optimum growth conditions assumed in design. Forage crops should be harvested and removed several times annually. Pine forest systems should be harvested at 20 to 25 year intervals. Hardwood forest systems should be harvested at 40 to 60 years. It is recommended that whole tree harvesting be considered to maximize nutrient removal. However, wastewater loadings following the harvesting of forest systems must be reduced until the hydraulic capacity of the site is restored. Spray field area to allow for harvesting and the regeneration cycle should be considered in design.

While high in nitrogen and phosphorus, domestic and municipal wastewaters are usually deficient in potassium and trace elements needed for vigorous agronomic cover crop growth. High growth rate forage crops such as Alfalfa and Coastal Bermuda will require supplemental nutrient addition to maintain nitrogen uptake rates assumed in design. Industrial wastewaters considered for irrigation should be carefully evaluated for their plant nutrient value.

## 16.9 Land Area Requirements

### 16.9.1 General

The land area to which wastewater is applied is termed a "field". The total land requirement includes not only the field area, but also land for any pre-application treatment facilities, storage reservoir(s), buffer zone, administration/maintenance structures and access roads. Field and buffer zone requirements are addressed in this Section. Land area for storage reservoirs is discussed in Section 16.10. All other land requirements will be dictated by standard engineering practices and will not be addressed in this document.

### 16.9.2 Field Area Requirements

The area required for the field is determined by using the following equation:

$$A = \frac{(Q_y + V)C}{Lwd} \qquad \text{Eq. 16-6}$$

where

A = field area, acres

$Q_y$ = Flow, MG per year

V = net loss or gain in stored wastewater due to precipitation, evaporation and/or seepage at the storage reservoir, gallons per day

Lwd = design hydraulic loading rate, in/year

$$C = \frac{1{,}000{,}000\ \text{gal}}{\text{MG}} \times \frac{\text{ft}^3}{7.48\ \text{gal}} \times \frac{12\ \text{in}}{\text{ft}} \times \frac{\text{acre}}{43{,}560\ \text{ft}^2} = 36.83$$

The first calculation of the field area must be made without considering the net gain or loss from the storage reservoir. After the storage reservoir area has been calculated, the value of V can be completed. The final field area is then recalculated to account for V. The Appendix includes the use of Equation 16-6.

### 16.9.3 Buffer Zone Requirements

The objectives of buffer zones around land treatment sites are to control public access, improve project aesthetics and, in case of spray irrigation, to minimize the transport of aerosols. Since development of off-site property adjacent to the treatment site may be uncontrollable, the buffer zone must be the primary means of separating the field area from off-site property. Table 16-3 gives minimum widths of buffer zones for varying site conditions:

Table 16-3
On-Site Buffer Zone Requirements

| | Surface Spread | Sprinkler Systems (Edge of Impact Zone) Open Fields | Forested |
|---|---|---|---|
| Site Boundaries | 100 ft. | 300 ft. | 150 ft. |
| On-site streams, ponds and roads | 50 ft. | 150 ft. | 75 ft. |

## 16.10 Storage Requirements

### 16.10.1 General

The design of a land application system must take into account that wastewater application will be neither continuous nor constant. Provisions must be made for containing wastewater when conditions exist such that either wastewater cannot be applied or when the volume of wastewater to be applied exceeds the maximum application rate.

The storage requirement can be determined by either of two methods. The first method involves the use of water balance calculations and is illustrated in Appendix A. The second method involves the use of a computer program that was developed based upon an extensive NOAA study of climatic variations throughout the United States. The program entitled EPA-2 would probably be the most appropriate of the three programs available. For information on the use of the computer program, contact the National Climatic Center of NOAA at (704) 259-0448.

### 16.10.2 Estimation of Storage Requirements Using Water Balance Calculations

The actual wastewater that is available is compared to the actual amount that can be applied. Any excess wastewater must be stored. The actual wastewater volume must be converted to units of depth for that comparison. Equation 16-7 will be used:

$$Wp = \frac{Qm \times C}{Ap} \qquad \text{Eq. 16-7}$$

where

Wp = depth of wastewater, in inches

Qm = volume of wastewater for each month of the year, in million gallons

$$C = \frac{1{,}000{,}000 \text{ gd}}{\text{MG}} \times \frac{\text{ft}^3}{7.48 \text{ gal}} \times \frac{\text{acre}}{43{,}560 \text{ ft}^2} \times \frac{12 \text{ in}}{\text{ft}} = 36.83$$

Ap = field area, in acres

The months in which storage is required are cumulated to determine the maximum amount of total storage needed. The use of the method is illustrated in Appendix A.

The maximum storage amount in inches, over the field area, is converted to a volume, in cubic feet. A suitable depth is chosen and a storage basin surface area is calculated.

This storage basin will be affected by three factors: precipitation, evaporation and seepage. These three factors are determined and the result is V, which is then introduced back into equation 16-6. A new, final field area is calculated and a corresponding new storage volume is determined.

In Tennessee, the maximum seepage is 1/4 inch per day. This amount can be used unless the storage basin will be constructed so that a lesser seepage rate will result. In some cases, where an impervious liner will be constructed, the seepage rate will be zero.

## 16.11 Distribution System

### 16.11.1 General

The design of the distribution system is a critical aspect of the land application. The field area and the storage volume were derived with the assumption that wastewater would be evenly distributed. For high strength wastes or wastes with high suspended/settleable solids, sprinkler applications are preformed. Sprinklers will distribute these wastes more evenly over the treatment area whereas surface application may result in accumulation of solids and odors near the application point.

16.11.2 Surface Spreading

With surface spreading, wastewater is applied to the ground surface, usually by perforated pipe or by an irrigation-type ditch, and flows uniformly over the field by gravity. The uniform flow is critically dependent upon a constant slope of the field, both horizontal and perpendicular to the direction of flow. Several other factors are of importance:

a. Uniform distribution cannot be achieved on highly permeable soils. The wastewater will tend to percolate into the soil that is nearest to the point of application.

b. A relatively large amount of wastewater must be applied each time so that wastewater will reach all portions of the field. The dosing must account for the fact that the field area nearest the point of application will be wetted for a longer period of time and, thus, will percolate more wastewater.

c. Erosion and/or runoff may be a problem. Since a surface discharge will not be allowed to occur, a return system may be necessary.

16.11.3 Sprinkler Spreading

Sprinkler systems can be classified into one of three general categories: (1) solid set, (2) portable and (3) continuously moving. The following factors should be considered during design:

a. The hydraulic conditions within the distribution system must be given a thorough review. Head losses through pipes, bends, nozzles, etc., must be balanced so that the wastewater is uniformly applied to the field.

b. Design must consider the effects of cold weather. Nozzles, risers, supply pipes, etc., must be designed to prevent wastewater from freezing in the various parts.

c. Wind can distort the spray pattern. Also, aerosols may be carried off the field area. A properly designed buffer zone should alleviate most of the aerosol problems. Also, the O&M manual can include a provision which would prevent spraying when the wind velocity is high enough to carry wastewater off the field area.

d. Crop selection is important. The higher humidity level may lead to an increase in crop disease.

e. Higher slopes can be used than in surface spreading (see Section 16.1.3). Also, slopes do not need to be constant. Further, the type of crop is nearly unlimited. Forests can be irrigated with solid set sprinklers. Forage crops can be irrigated with any of the three basic types of systems.

f. The system layout must take into consideration the method that will be used for harvesting the crop.

16.12 Spray Irrigation of Wastewater from Gray Water Facilities

16.12.1 General

This Section provides criteria for facilities that produce a "gray water" wastewater. These facilities include coin-operated laundries, car washes and swimming pool backwash filters. Wastewater disposal requirements are not as complex as are those for domestic wastewater. An engineering report which provides information on the design of the facilities must be submitted to the Division.

16.12.2 Site Location

16.12.2.1 The Division of Water Pollution Control must inspect and approve the proposed site prior to any construction being undertaken.

16.12.2.2 The site must be chosen such that the operation of the system will not affect surrounding property owners. No surface runoff or stream discharge will be allowed.

16.12.3 Design Flow

Since these are service enterprises, the amount of wastewater that is generated is directly related to the desire of people to use the facilities. Thus, an estimate of the number of potential users (and frequency) is extremely important. Various factors must be taken into consideration:

a. A rural setting would tend to have a shorter daily usage period than would an urban location.

b. An area that is predominately single-family houses would tend to have a lesser usage rate for laundries and car washes than would an area with apartment complexes.

c. The amount of water that washing machines use will vary among manufacturers and models. The Division recommends the use of water-saving machines.

The engineer should use 250 gpd/washer for laundries and 700 gpd/bay for car washes unless more reliable data is available.

16.12.4 Pre-treatment

16.12.4.1 General

Facilities that produce gray water have different pretreatment requirements, designed not only to the type of facility but also to the specific establishment.

16.12.4.2 Laundries

a. All laundry wastewater (does not include sanitary wastes) shall pass through a series of lint screens. A series will consist of five screens, starting with a screen with 1-inch mesh and ending with a screen that is basically equivalent to a window screen.

b. Since some detergents produce a wastewater with a pH in the range of 11.0 - 11.5, some type of pH adjustment may be necessary. This may occur as a retrofit if the vegetation in the spray plots is being stressed by the high pH.

c. Disinfection will generally not be required unless the operation of the facilities will result in a potential hazard to the public. The need for disinfection will be determined by the Division on a case-by-case basis.

16.12.4.3 Car Washes

a. All car wash wastewater shall pass through a grit removal unit. The flow-through velocity shall be less than 0.5 feet per second. The grit removal unit shall be constructed to facilitate the removal of grit.

b. The use of detergents with a neutral (or nearly neutral) pH is recommended. The use of high-pH detergents may require neutralization if the vegetation is being stressed by the high pH.

16.12.4.4 Swimming Pools

a. A holding tank/pond shall be provided to receive the backwash water from the swimming pool filters. The solids shall be allowed to settle to the bottom before the supernatant is removed for disposition on the spray plots.

b. Dechlorination may be required if the vegetation on the plots is being stressed by the chlorine in the water.

c. If the entire pool volume is to be emptied, by using the spray plots, the rate shall be controlled so as to not exceed the application rate that is specified in Section 16.7.1.

16.12.5 Field Requirements

16.12.5.1 The maximum wastewater that can be sprayed on a site is based either on the nitrogen content of the wastewater or an amount equal to 10% of the infiltration rate of the most restrictive layer of soil which shall be determined with input from a qualified soil scientist.

16.12.5.2 The application of wastewater shall alternate between at least two separate plots. Each plot shall not receive wastewater for more than three consecutive days and must have at least three days rest between applications. Reserve land area of equivalent capacity must be available for all greg water systems.

16.12.5.3 Ground slopes shall not exceed 30%. Extra precautions must be taken on steep slopes (15-30%) to prevent runoff and erosion.

16.12.5.4 The field shall be covered with a good lawn or pasture grass unless an existing forested area is chosen. The ground cover should be a sturdy perennial that will resist erosion and washout. Forested areas should be chosen so that installation of sprinkler equipment will not damage the root systems of the trees and will not produce runoff due to the usual lack of grass in forested areas.

16.12.6 Application Equipment

16.12.6.1 Sprinklers shall be of a type and number such that the wastewater will be evenly distributed over the entirety of a plot. Information on sprinklers shall be included in the engineering report. In forest plots, sprinklers shall be on risers which shall be tall enough to allow the wastewater to be sprayed above the undergrowth. Sprinklers shall be of the type that are not susceptible to clogging.

16.12.6.2 All piping (excluding risers) shall be buried to a depth that will prevent freezing in the lines. An exception to this burial requirement can be made in the case where piping will be laid in forested areas. Burial in this case may be difficult, expensive and may kill some trees. All risers shall be designed such that wastewater will drain from them when wastewater is not being pumped. This can be accomplished by either draining all lines back into the pump sump or by placing a gravel drain pit at the base of each riser. Each riser would necessarily be equipped with a weep hole. Particular attention must be given during the design so that the entire subsurface piping does not drain into these pits.

16.12.6.3 The engineering report must contain hydraulic calculations that show that each nozzle distributes an equivalent amount of wastewater. Differences in elevation and decreasing pipe sizes will be factors which need to be addressed.

16.12.6.4 The piping must be of a type that will withstand a pressure equal to or greater than 1-1/2 times the highest pressure point in the system. The risers should be of a type of material such that they can remain erect without support. The pipe joints should comply with the appropriate ASTM requirements. Adequate thrust blocks shall be installed as necessary.

16.12.6.5 A sump shall be provided into which the wastewater will flow for pumping to the spray plots. The pump can be either a submersible type, located in the sump, or a dry-well type, located immediately adjacent to the sump in a dry-well. The pump shall be capable of pumping the maximum flow that can be expected to enter the sump in any 10-minute period. The pump shall be operated by some type of float mechanism. The float mechanism shall activate the pump when the water level reaches 2/3 of the depth of the sump and should de-activate the pump before the water level drops to the point to where air can enter the intake.

If the distribution system is designed to drain back into the sump, the sump shall be enlarged to account for that volume.

If desired, the sump for laundries can also contain the lint screens. The screens shall, in any case, be constructed so that they cannot be bypassed. They shall be built so that they can be easily cleaned. A container shall be provided for disposal of the lint which is removed from the screens.

16.12.6.6 The pipe from the facility to the sump shall be large enough to handle the peak instantaneous flow that could be realistically generated by the facility. Flow quantities, head loss calculations, etc., shall be included in the engineering report.

16.12.7 Operation of System

16.12.7.1 The operator shall insure that wastewater is applied to alternate plots on a regular basis.

16.12.7.2 Monthly operating reports shall be submitted to the appropriate field office of the Division of Water Pollution Control. The parameters to be reported shall be delineated by field office personnel but should include, as a minimum, dates of spray plot alternation.

16.12.7.3 The owner of the system shall apply for and receive an operating permit from the Division prior to initiation of operation of the system.

16.12.7.4 The system operator shall inspect and maintain the pump and sprinklers in accordance with manufacturer's recommendations. An operations manual shall be located at the facility for ready reference.

16.12.7.5 The operator shall inspect the wastewater facilities on a regular basis. The inspection shall include the spray plots to determine whether or not runoff and/or erosion are or have occurred, the spray patterns of the sprinklers, the physical condition of the system (looking for damage due to adverse pH conditions), etc.

16.12.7.6 The spray plots shall be mowed on a regular basis to enhance evapotranspiration. Grass height shall not exceed 6".

16.12.7.7 The lint screen at laundries shall be cleaned on a schedule that is frequent enough to prevent upstream problems due to head loss through the screens. Disposition of the lint shall be in accordance with applicable requirements.

16.12.7.8 The grit traps at car washes shall be cleaned at a frequency that is sufficient to keep the trap in its designed operating condition.

16.12.7.9 If the car wash is equipped with an automatic wax cycle, the operator shall be especially attentive to the possibility of wax build-up on the sump, pump and all downstream piping.

16.12.7.10 The operator shall insure that the car wash facility is not used as a sanitary dumping station for motor homes or for washing trucks/trailers that are used for hauling livestock. If necessary, the facility shall be posted with signs which clearly indicate this prohibition.

16.12.7.11 The sludge holding tank/pond at a swimming pool facility shall be cleaned at a frequency that is sufficient to prevent solids from being carried over into the pump sump. Cleaning shall be performed in a manner that will minimize re-suspending the solids and allowing them to enter the pump sump.

16.13 Plan of Operation and Management

A plan of Operation and Management is required before an Operating Permit can be issued. The Plan is written by the owner or the owner's engineer during construction of the slow rate land treatment system. Once accepted by the Division, the Plan becomes the operating and monitoring manual for the facility and is incorporated by reference into the Permit. This manual must be kept at the facility site and must be available for inspection by personnel from the Tennessee Department of Health and Environment.

This Plan should include, but not be limited to, the following information:

16.13.1 Introduction

a. System Description:

1. A narrative description and process design summary for the land treatment facility including the design wastewater flow, design wastewater characteristics, pre-application treatment system and spray fields.

2. A map of the land treatment facility showing the pre-application treatment system, storage pond(s), spray fields, buffer zones, roads, streams, drainage system discharges, monitoring wells, etc.

3. A map of force mains and pump stations tributary to the land treatment facility. Indicate their size and capacity.

4. A schematic and plan of the pre-application treatment system and storage pond(s) identifying all pumps, valves and process control points.

5. A schematic and plan of the irrigation distribution system identifying all pumps, valves, gauges, sprinklers, etc.

b. Discuss the design life of the facility and factors that may shorten its useful life. Include procedures or precautions which will compensate for these limitations.

c. A copy of facility's Tennessee Operating Permit.

16.13.2 Management and Staffing

a. Discuss management's responsibilities and duties.

b. Discuss staffing requirements and duties:

1. Describe the various job titles, number of positions, qualifications, experience, training, etc.

2. Define the work hours, duties and responsibilities of each staff member.

16.13.3 Facility Operation and Management

a. Pre-application Treatment System:

1. Describe how the system is to be operated.

2. Discuss process control.

3. Discuss maintenance schedules and procedures.

b. Irrigation System Management:

1. Wastewater Application. Discuss how the following will be monitored and controlled. Include rate and loading limits.

(a) Wastewater loading rate (inches/week)

(b) Wastewater application rate (inches/hour)

(c) Spray field application cycles

(d) Organic, nitrogen and phosphorus loadings (lbs/acre per month, etc)

2. Discuss how the system is to be operated and maintained.

(a) Storage pond(s)

(b) Irrigation pump station(s)

(c) Spray field force main(s) and laterals

3. Discuss start-up and shut-down procedures.

4. Discuss system maintenance.

(a) Equipment inspection schedules

(b) Equipment maintenance schedules

5. Discuss operating procedures for adverse conditions.

(a) Wet weather

(b) Freezing weather

(c) Saturated Soil

(d) Excessive winds

(e) Electrical and mechanical malfunctions

6. Provide troubleshooting procedures for common or expected problems.

7. Discuss the operation and maintenance of back-up, stand-by and support equipment.

c. Vegetation Management:

1. Discuss how the selected cover crop is to be established, monitored and maintained.

2. Discuss cover crop cultivation procedures, harvesting schedules and uses.

3. Discuss buffer zone vegetative cover and its maintenance.

d. Drainage System (if applicable):

1. Discuss operation and maintenance of surface drainage and runoff control structures.

2. Discuss operation and maintenance of subsurface drainage systems.

16.13.4 Monitoring Program

a. Discuss sampling procedures, frequency, location and parameters for:

1. Pre-application treatment system.

2. Irrigation System:

(a) Storage pond(s)

(b) Groundwater monitoring wells

(c) Drainage system discharges (if applicable)

(d) Surface water (if applicable)

b. Discuss soil sampling and testing:

c. Discuss ambient conditions monitoring:

1. Rainfall

2. Wind speed

3. Soil moisture

d. Discuss the interpretation of monitoring results and facility operation:

1. Pre-application treatment system.

2. Spray fields.

3. Soils.

16.13.5 Records and Reports

a. Discuss maintenance records:

1. Preventive.

2. Corrective.

b. Monitoring reports and/or records should include:

1. Pre-application treatment system and storage pond(s).

(a) Influent flow

(b) Influent and effluent wastewater characteristics

2. Irrigation System.

   (a) Wastewater volume applied to spray fields.

   (b) Spray field scheduling.

   (c) Loading rates.

3. Groundwater Depth.

4. Drainage system discharge parameters (if applicable).

5. Surface water parameters (if applicable).

6. Soils data.

7. Rainfall and climatic data.

APPENDIX A

Due to the complexity of working with all of the variables that are inherent with land application systems, the most beneficial use of these criteria might be afforded by designing a slow-rate irrigation system for a hypothetical town in Tennessee. The following information is given:

Given: The town is in the Cumberland Plateau Section

The first step involves Equation 16-2, the water balance equation:

$$Lwh = (PET + Perc) - Pr \qquad \text{Eq. 16-2}$$

The Thornthwaite equation, Equation 16-3, will be used to derive the potential evapotranspiration (PET) term:

$$PET = 0.63 \times S \times \frac{\underline{50 \times (T-32)}^{A}}{9 \times I} \qquad \text{Eq. 16-3}$$

The use of this equation requires that daylight hours at the particular latitude and the monthly air temperatures be used. Tennessee lies between latitudes of about $35^{O}$ and $36^{O}$ 40'. Since the latitudinal distance in Tennessee is not large, the daylight hours at the $36^{o}$

latitude will be adequate for any town in Tennessee. Table A-1 lists the average monthly daylight hours, in units of 12 hours, $36^o$ latitude.

Table A-1
Monthly Average Daylight Hours (S), in Units of 12 hours, for the $36^{O}$ Latitude $36^{0}$

| | |
|---|---|
| January | 0.84 |
| February | 0.91 |
| March | 1.00 |
| April | 1.09 |
| May | 1.17 |
| June | 1.21 |
| July | 1.19 |
| August | 1.12 |
| September | 1.04 |
| October | 0.94 |
| November | 0.86 |
| December | 0.81 |

The National Oceanic and Atmospheric Administration has published information on air temperature. A 30-year monthly average for the Cumberland Plateau Section, for the period of 1951 - 1980, will be used. Table A-2 is used to show the monthly daylight hours, air temperature and PET for this system.

Table A-2
Data Used, and Results Derived, for PET

| | S at 36 Degree Latitude | Air Temp. Degrees Fahrenheit | PET, inches per month |
|---|---|---|---|
| January | 0.84 | 35.6 | 0.10 |
| February | 0.91 | 38.6 | 0.27 |
| March | 1.00 | 46.9 | 0.97 |
| April | 1.09 | 57.3 | 2.30 |
| May | 1.17 | 64.7 | 3.59 |
| June | 1.21 | 71.6 | 4.90 |
| July | 1.19 | 75.0 | 5.44 |
| August | 1.12 | 74.3 | 5.00 |
| September | 1.04 | 68.8 | 3.79 |
| October | 0.94 | 57.3 | 1.98 |
| November | 0.86 | 46.7 | 0.82 |
| December | 0.81 | 39.1 | 0.27 |

TOTAL = 29.43

Air temperature data for a specific location can be used, but its use must be documented by the NOAA. Also, other methods of calculating the PET can be used, provided that the use of an alternate method has been given prior approval by the TDHE.

Table A-3 is an indication of the Pr value in Eq. 16-2. Section 16.7.4 contains Equation 16-4 which is used in this case:

Pr = Pr (average) + (0.85 x std. dev.) Eq. 16-4

Table A-3
Five-Year Annual Rainfall, Using the 30-Year
Average Monthly Rainfall and Standard Deviation

| | 30-Year Average Rainfall, Inches | Standard Deviation | Pr Inches |
|---|---|---|---|
| January | 5.46 | 2.54 | 7.62 |
| February | 4.83 | 2.22 | 6.72 |
| March | 6.45 | 2.82 | 8.85 |
| April | 4.95 | 1.93 | 6.59 |
| May | 4.75 | 1.62 | 6.13 |
| June | 4.32 | 1.41 | 5.52 |
| July | 5.06 | 2.10 | 6.85 |
| August | 3.60 | 1.33 | 4.73 |
| September | 4.10 | 1.69 | 5.54 |
| October | 3.08 | 1.63 | 4.47 |
| November | 4.39 | 2.02 | 6.11 |
| December | 5.43 | 2.49 | 7.55 |
| TOTAL | 56.42 | | 76.68 |

An assumption is made that a site, with adequate acreage, has been selected, based on a site study. The following information is given:

Given: the most limiting soil layer has an infiltration rate of 0.3 inches/hour.

0.3 in/hr x 24 hr/day x 7 day/week x 0.10 = 5.04 in/week.

The 0.10 figure is the 10 percent design percolation limit.

Given: Wastewater can be applied in January only ten days, due to frozen soil, snow cover, etc.

Given: Wastewater can be applied in February and December on only 20 days.

Equation 16-2 can now be used to determine the maximum allowable monthly hydraulic wastewater loading, Lwh. Table A-4 illustrates the results:

Table A-4
Determination of Maximum Allowable Monthly
Hydraulic Wastewater Loading, D (allowed), Inches/Month

| | (1) PET | (2) Pr | (3) (1)-(2) | (4) Perc. | (5) Lwh (3)+(4) |
|---|---|---|---|---|---|
| January | 0.10 | 7.62 | -7.52 | 7.20 | 0 |
| February | 0.27 | 6.72 | -6.45 | 14.40 | 7.95 |
| March | 0.97 | 8.85 | -7.88 | 22.32 | 14.44 |
| April | 2.30 | 6.59 | -4.29 | 21.60 | 17.31 |
| May | 3.59 | 6.13 | -2.54 | 22.32 | 19.78 |
| June | 4.90 | 5.52 | -0.62 | 21.60 | 20.98 |
| July | 5.44 | 6.85 | -1.41 | 22.32 | 20.91 |
| August | 5.00 | 4.73 | 0.27 | 22.32 | 22.59 |
| September | 3.79 | 5.54 | -1.75 | 21.60 | 19.85 |
| October | 1.98 | 4.47 | -2.49 | 22.32 | 19.83 |
| November | 0.82 | 6.11 | -5.29 | 21.60 | 16.31 |
| December | 0.27 | 7.55 | -7.28 | 14.40 | 7.12 |
| TOTALS | 29.43 | 76.68 | -47.25 | 234.00 | 187.07 |

Based upon a maximum infiltration rate of 5.04 in/week, a water loss (PET), and a precipitation water gain, column 5 illustrates the maximum yearly and monthly hydraulic wastewater application rates. These rates will be used in the design of the system unless other limitations occur.

The most important of those other limitations is the percolate nitrogen concentration. If percolating water from a slow rate (SR) system will enter a potable ground water aquifer, then the system should be designed such that the concentration of nitrate nitrogen in the receiving ground water at the project boundary does not exceed 10 mg/l. Section 16.8.1 indicates that the nitrate concentration in the percolate must not exceed 10 mg/l. The approach to meeting this requirement involves estimating an allowable monthly hydraulic loading rate based on an annual nitrogen balance and comparing these monthly rates to the monthly rates that are based on an application rate of 2.5 inches/week.

Equation 16-5 is used to determine monthly wastewater application rates based on a nitrate concentration of 10 mg/l.

$$Lwn = \frac{Cp\ (Pr - PET) + U\ (4.424)}{(1\text{-}f)\ (Cn) - Cp} \qquad \text{Eq. 16-5}$$

The following information is given:

Given: Cp = 10 mg/l
Given: Cn = 25 mg/l
Given: f = 25%
Given: U = 200 pounds/acre/year. This uptake is not constant; rather, the uptake is at a minimum in the cold months and is at a maximum in the warm months. Table A-5 indicates what percentage of U was allocated to each month.
Given: Pr and PET have been developed previously and have been included in Table A-5.

The monthly use of Equation 16-5 is illustrated in Table A-5. Also, this table includes a comparison of the monthly rates that were developed from the infiltration and the nitrogen bases.

Table A-5
Determination of Maximum Allowable Monthly Hydraulic
Wastewater Loading Based on Nitrogen Concentration
Comparison Between Infiltration and Nitrogen Loading Rates

| | (2) Pr in. | (1) PET in. | U % | (6) lbs. | (7) Lwn in./mo. | (5) Lwh in./mo. | (8) Lwd in./mo. |
|---|---|---|---|---|---|---|---|
| January | 7.62 | 0.10 | 1 | 2 | 9.61 | 0 | 0 |
| February | 6.72 | 0.27 | 2 | 4 | 9.39 | 7.95 | 7.95 |
| March | 8.85 | 0.97 | 4 | 8 | 13.05 | 14.44 | 13.05 |
| April | 6.59 | 2.30 | 8 | 16 | 12.99 | 17.31 | 12.99 |
| May | 6.13 | 3.59 | 12 | 24 | 15.04 | 19.78 | 15.04 |
| June | 5.52 | 4.90 | 15 | 30 | 15.88 | 20.98 | 15.88 |
| July | 6.85 | 5.44 | 17 | 34 | 18.80 | 20.91 | 18.80 |
| August | 4.73 | 5.00 | 15 | 30 | 14.86 | 22.59 | 14.86 |
| September | 5.54 | 3.79 | 12 | 24 | 14.13 | 19.85 | 14.13 |
| October | 4.47 | 1.98 | 8 | 16 | 10.94 | 19.83 | 10.94 |
| November | 6.11 | 0.82 | 4 | 8 | 10.09 | 16.31 | 10.09 |
| December | 7.55 | 0.27 | 2 | 4 | 10.34 | 7.12 | 0 |
| TOTALS | 76.68 | 29.43 | 100 | 200 | 155.12 | 187.07 | 133.73 |

As can be seen in Table A-5, soil infiltration is the limiting factor in the months of December, January and February. All other months have a limiting factor that is based on the nitrogen uptake rates of the crop.

The preliminary amount of land, Ap, that will be necessary for application of wastewater is determined by using Equation 16-6:

$$Ap = \frac{(Q_y + V)\,C}{(Lwd)} \qquad \text{Eq. 16-6}$$

The equation will be first solved without using the V term. The following information is given:

Given: Qy = MG per year = 36.5 MG
Given: Lwd = 133.73 inches/year (see column (8) Table A-5)
Given: C = 36.83

Substituting into Equation 16-6 gives the following:

$$Ap = 10.05 \text{ acres}$$

This preliminary acreage is used in determining storage needs. When the storage requirements are determined, the V term can then be a derived and the actual field area, Af, can be calculated.

Storage volume requirements will be performed here by using water balance calculations. The basic steps are as follows:

1. The available monthly wastewater volume is converted to a unit of depth, in inches, by using the following equation:

$$Wp = \frac{Qm \times 36.83}{Ap} \qquad \text{Eq. 16-7}$$

In using the equation, the Qm term is assumed to be either 3.1 MGM, 3.0 MGM or 2.8 MGM, depending on the number of days in any particular month. No yearly variation is taken into account. In actuality, infiltration and inflow (I/I) and daily flow variations will require actual flow values.

Table A-6 is illustrative of the use of Eq. 16-7.

Table A-6
Estimation of Storage Volume Requirements
Using Water Balance Calculations

| | (8) Lwd | (9) Wp | (10) Change (9)-(8) | (11) Cumulative Storage |
|---|---|---|---|---|
| January | 0.00 | 11.36 | 11.36 | 24.04 |
| February | 7.95 | 10.26 | 2.31 | 26.35(b) |
| March | 13.05 | 11.36 | -1.69 | 24.66 |
| April | 12.99 | 10.99 | -2.00 | 22.66 |
| May | 15.04 | 11.36 | -3.68 | 18.98 |
| June | 15.88 | 10.99 | -4.89 | 14.09 |
| July | 18.80 | 11.36 | -7.44 | 6.65 |
| August | 14.86 | 11.36 | -3.50 | 3.15 |
| September | 14.13 | 10.99 | -3.14 | 0.01(c) |
| October | 10.94 | 11.36 | 0.42(a) | 0.42 |
| November | 10.09 | 10.99 | 0.90 | 1.32 |
| December | 0.00 | 11.36 | 11.36 | 12.68 |
| | 133.73 | 133.74 | | |

(a) Starting at October, in this example, will result in the maximum storage.
(b) Maximum storage.
(c) Rounding error; assume zero.

The storage volume is calculated by multiplying the maximum cumulative storage by the field area, as indicated below:

Storage volume = (26.35 in) (10.05 acres) (ft/12 in) (43,560 $ft^2$/acre)

= 961,000 $ft^3$ (rounded off)

The storage volume will be dependent upon three factors: precipitation, evaporation, and allowed seepage. To obtain the final volume, the following steps are used:

1. Calculate the area of the storage volume.

Assume a maximum depth of 10 feet

Area = Volume _ depth

Area = 961,000 $ft^3$ _ 10 ft

Area = 96,100 $ft^2$

2. Determine the monthly gain or loss in storage volume due to precipitation, evaporation and seepage in accordance with the following equation (see Table A-7):

   Vm = (Pr - evaporation - seepage)

   Column 14 is the result of using this equation. Precipitation has been presented previously in Table A-5. Evaporation is assumed to be 20 inches per year, distributed monthly in the same ratios of monthly PET to annual PET. Seepage rate shall not exceed 1/4 inch per day, in accordance with criteria in Chapter 9.

   Vm is converted from inches (Column 14) to MG (Column 15) by using the following equation:

   Vm = (Column 14) x 1 ft/12 in x 96,100 $ft^2$ x 7.48 gal/$ft^3$ x 1 MG/1,000,000 gal

   Vm = (Column 14) x 0.0599

3. The monthly storage losses and gains are added for a yearly total, Vt. This term is inserted back into Eq. 16-6 to calculate the actual, final field area.

   $$A = \frac{(Qy + Vt)C}{Lwd} \qquad \text{Eq. 16-6}$$

   where Qy = 36.5 MG

   Vt = -2.073 (from Column 15, Table A-7)

   C = 36.83

   Lwd = 133.73 in/year

   Substituting into Eq. 16-6 yields the following:

   Af = 9.48 acres

4. The water loss or gain is substracted or added to the monthly available wastewater, previously used in Eq. 16-7 (see Columns 15, 16 and 17, Table A-7).

5. The monthly available wastewater amounts, from column 17 of Table A-7, are converted to depths, in inches, by using Eq. 16-7.

$$Wf = \frac{Qm \times (36.83)}{A_f} \qquad \text{Eq. 16-7}$$

where

$Qm$ = MG

$Af$ = 9.48 acres

6. Substituting the monthly values of $Q_{mf}$ into Eq. 16-7 yields column 18 of Table A-7. This is the amount of wastewater that will be available, in inches per month, for application to the field.

7. The available wastewater will be limited to field application due to weather, soil conditions, etc. This has been determined previously, was shown as Column 8 in Table A-5 and is re-indicated in Column 8 in Table A-7.

8. The difference between available wastewater and the amount that can be applied to the field is indicated in Column 19 of Table A-7. This column is derived by subtracting Column 8 from Column 18. A positive number indicates that more wastewater is available than can be applied; thus, storage is necessary. A negative number indicates that the soil can receive more wastewater than is received on a daily basis; thus, the wastewater that has been stored can be applied to the field along with the daily flow.

9. The cumulative storage is re-calculated, beginning with the storage basin(s) empty; in this case, at the beginning of October. This cumulative storage is shown in Column 20 of Table A-7 and indicates that a storage basin must be large enough to contain a volume of water equal to 27.00 inches of wastewater over the field area of 9.48 acres.

   The final storage volume is determined as follows:

   Vol. = (27.00 in) (9.48 acres) (ft/12 in) (43,560 ft2/acre)

   Vol. = 929,000 ft3 (rounded off)

10. Without changing the surface area of 96,100 ft2, the depth is re-calculated:

Depth = Volume _ area

= 929,000 ft3 _ 96,100 ft2

Depth = 9.67 feet

Table A-7

| | (2)<br>Water loss/gain, V<br>Pr<br>inches | (12)<br><br>Evap.<br>inches | (13)<br>Wastewater<br>Seepage,<br>inches | (14)<br><br>(2)-(12)-(13)<br>inches | (15)<br><br>Qm<br>MG | (16)<br><br>Qmf<br>MG | (17)<br><br>Wf<br>(16)+(15) |
|---|---|---|---|---|---|---|---|
| January | 7.62 | 0.07 | 7.75 | -0.20 | -0.012 | 3.1 | 3.088 |
| February | 6.72 | 0.18 | 7.00 | -0.46 | -0.028 | 2.8 | 2.772 |
| March | 8.85 | 0.66 | 7.75 | 0.44 | 0.026 | 3.1 | 3.126 |
| April | 6.59 | 1.56 | 7.50 | -2.47 | -0.148 | 3.0 | 2.852 |
| May | 6.13 | 2.44 | 7.75 | -4.06 | -0.243 | 3.1 | 2.857 |
| June | 5.52 | 3.33 | 7.50 | -5.31 | -0.318 | 3.0 | 2.682 |
| July | 6.85 | 3.70 | 7.75 | -4.60 | -0.276 | 3.1 | 2.824 |
| August | 4.73 | 3.40 | 7.75 | -6.42 | -0.385 | 3.1 | 2.715 |
| September | 5.54 | 2.58 | 7.50 | -4.54 | -0.272 | 3.0 | 2.728 |
| October | 4.47 | 1.34 | 7.75 | -4.62 | -0.277 | 3.1 | 2.823 |
| November | 6.11 | 0.56 | 7.50 | -1.95 | -0.117 | 3.0 | 2.883 |
| December | 7.55 | 0.18 | 7.75 | -0.38 | -0.023 | 3.1 | 3.077 |
| Total | 76.68 20.00 | 91.25 | -34.57 | -2.073 | 36.5 | 34.427 | 133.75 |

RDL/E6078048
Appendix A
Sewer Regs

Table 16-1
HYDRAULIC CONDUCTIVITY TEST METHODS

1.0 SATURATED VERTICAL HYDRAULIC CONDUCTIVITY[a]

1.1 Laboratory Tests:[b]

| | |
|---|---|
| Constant Head Method (coarse grained soils) | ASTM D 2434-68<br>AASTHO T 215-70<br>Bowles (1978), pp 97-104<br>Kezdi (1980), pp 96-102 |
| Falling Head Method[c] (cohesive soils) | Bowles (1978), pp 105-110<br>Kezdi (1980), pp 102-108 |

1.2 Field Tests:

| | |
|---|---|
| Flooding Basin Method[c] | U.S. EPA (1981), pp 3-13 to 15 |
| Ring Permeameter Method | Boersma (1965)<br>U.S. EPA (1981), pp 3-22 to 23 |
| Double Tube Method[c] | Bouwer and Rice (1967)<br>U.S. EPA (1981), pp 3-17 to 24 |
| Air-Entry Permeameter[c] Method | Bouwer (1966)<br>Reed and Crites (1984), pp 176 to 180<br>Topp and Binns (1976)<br>U.S. EPA (1981), pp 3-24 to 27 |

2.0 SATURATED HORIZONTAL HYDRAULIC CONDUCTIVITY[d]

2.1 Field Tests:

| | |
|---|---|
| Auger Hole Method | Reed and Crites (1984), pp 165 to 168<br>U.S. EPA (1984), pp 3-32 to 35<br>U.S. Dept. of Interior (1978), pp 55-67 |
| Slug Test | Bouwer and Rice (1976) |

a Other methods, properly documented, may be accepted by the TDHE. However, "standard" percolation tests as performed for septic tank drain fields are not acceptable.

b These tests require undisturbed field samples properly prepared to insure saturation. Reconstructed field samples are not acceptable. A description of the field sampling technique should accompany the laboratory testing results.

c Methods recommended by the TDHE.

d Testing for saturated horizontal hydraulic conductivity is required at land treatment sites where drainage improvements are planned and where lateral, as opposed to vertical, subsurface drainage is the predominant drainage pathway.

Table 16-2
Suggested Values for Inorganic Constituents
in Wastewater Applied to Land

| | Potential Problem and Constituent Severe | No Problem | Increasing |
|---|---|---|---|
| pH (std. units) | 6.5 - 8.4 | | <5.0 >9.0 |
| Permeability | | | |
| Electrical Conductivity (mho/cm) | >0.50 | <0.50 | <0.2 |
| Sodium Adsorption Ratio (a) | <5.0 | 5.0 - 9.0 | >9.0 |
| Salinity | | | |
| Electrical Conductivity (mmho/cm) | <0.75 | 0.75 - 3.0 | >3.0 |
| Specific Ion | | | |
| Anions: | | | |
| Bicarbonate (meq/l) | <1.5 | 1.5 - 8.5 | >8.5 |
| (mg/l as CaCO3) | <150 | 150 - 850 | >850 |
| Chloride (meq/l) | <3.0 | >3.0 | >10 |
| (mg/l) <100 | >100 | >350 | |
| Fluoride (mg/l) | <1.8 | | |
| Cations: | | | |
| Ammonia (mg/l as N) | <5.0 | 5.0 - 30 | >30 |
| Sodium (meq/l) | <3.0 | >3.0 | >9.0 |
| (mg/l) <70 | >70 | | |
| Trace Metals (mg/l): | | | |
| Aluminum | <10 | | |
| Arsenic | <0.2 | | |
| Beryllium<0.2 | | | |
| Boron | <0.5 | 0.5 - 2.0 | >2.0 |
| Cadmium | <0.02 | | |
| Chromium | <0.2 | | |

| | |
|---|---|
| Cobalt | <0.1 |
| Copper | <0.4 |
| Iron | <10 |
| Lead | <10 |
| Lithium | <2.5 |
| Manganese | <0.4 |
| Molybdenum | <0.02 |
| Nickel | <0.4 |
| Selenium <0.04 | |
| Zinc | <4.0 |

a Sodium Adsorption Ratio = $\frac{Na+1}{SQR(\ Ca+2 + Mg+2)/\ 2)}$

Where, Na+1, Ca+2 and Mg+2 in the wastewater are expressed in milliequivalents per liter (meq/l). SQR represents 'square root of'.

## 2.3 REQUIREMENTS FOR DRIP EMITTER SYSTEMS

Chapter 16 of the Department of Environment and Conservation's Design Criteria does not address the use of drip emitter systems for the disposal of the treated effluent. Drip emitter systems are acceptable for use in disposal of the treated wastewater. The following provisions shall apply for drip emitter systems:

1. BUFFER ZONES, PUBLIC ACCESS AND PROTECTION OF WATER SUPPLY WELLS

Buffer zones are required to provide adequate access to buried drip lines and to ensure that no wastewater leaves the site. The following minimum buffer zones must be provided for all systems:

a. A 25-foot buffer must be maintained between the edge of the subsurface piping and the property line. A minimum 50-foot buffer must be maintained between the edge of surface piping and the property line. This requirement is subject to change as a result of site topography and the flushing system provided.

b. A 25-foot undisturbed natural vegetative buffer is required between the drip piping and the edge of any perennial lake, stream, or channelized intermittent watercourse. If application of wastewater causes a non-channelized intermittent watercourse to become perennial, a 25-foot buffer requirement will apply. All buffer requirements for trout streams and sedimentation and erosion control will also apply. Any local ordinances or requirements more stringent will govern.

c. A 300-foot buffer must be maintained between any habitable structure and any part of the on-site pre-treatment and storage facility. This requirement does not apply to the underground septic tank or interceptor tanks. Septic tanks must be installed in accordance with the local health department requirements. This 300-foot buffer shall not extend beyond the property line of the development. However, this buffer may extend into but not beyond public road rights-of-way dedicated to a governmental entity and railroad rights-of-way.

d. Requirements for buffer areas in relation to potable water wells will be determined after reviewing groundwater pollution susceptibility and groundwater recharge maps or by contacting the Division of Water Supply, Tennessee Department of Environment and Conservation. In no case shall a wastewater application system be located within 300 feet of a drinking water well. Wellhead Protection requirements may increase the buffer distances as necessary.

In order to protect the drinking water aquifers, abandoned water supply wells within the treatment site must be identified along with all public water supply wells within 1,500 linear feet of any community land treatment site and all private water supply wells within 500 linear feet of any community land treatment site. Shallow wells within 500 feet of a community land treatment system will require monitoring along with all other monitoring wells.

Public access to the disposal field shall be restricted by posting signs and fencing of disposal fields. Fencing and access road gates shall be provided along property lines adjacent to residential and other developed areas. Fencing is required around all wastewater treatment systems, storage facilities, pump stations, and holding ponds.

## 2. SURFACE DRAINAGE AND RUN-OFF CONTROL

Drainage of storm run-off should be considered in the design of drip irrigation systems. All land application fields must be protected against flooding (below 10 year flood elevation), ponding and erosion. Run-off from upgradient areas should be redirected around the irrigation site. If properly designed and constructed, drip irrigation systems will not produce any runoff if surface applied or any surface flow of wastewater if subsurface applied. All areas that acquire a wet surface should have the hydraulic loading rate reduced to prevent the situation from recurring. Areas exhibiting a wet surface on a regular basis must be eliminated from future applications unless the surface wetting can be corrected. A reassessment of the design should be performed to determine if reconstruction or repair of the failing area would correct the deficiency. Any areas taken out of service because of failure will subsequently cause a reduction in the permitted system capacity.

Indirect runoff as a result of underflow, changes in slope, and shallow restrictive soil layers can be anticipated at some slow rate land treatment sites. Indirect runoff may be acceptable if it is dispersed over a wide area. However, monitoring of streams affected by such indirect runoff will be required.

Water resulting from line flushing must be dispersed over a wide area. No flush waters shall be permitted to flow off the site onto adjoining property. Direct discharge of these flows into any water course is prohibited. Effluent from line flushing should be absorbed by the surrounding area within a few minutes of line flushing. Line flushing should not be performed during any rain event.

## 3. DISTRIBUTION SYSTEMS, MAINTENANCE AND CONSTRUCTION

Hydraulic calculations for the pump and distribution system must be submitted for review in the DDR. Field pressure and flow variation due to friction loss and changes in static head should not exceed plus or minus 10% of the design emitter pressure or flow. If this criterion cannot be met, revisions to field layout, emitter output, or any other viable option should be used to comply with this requirement. The system will not be allowed to initiate operations if the total flow or pressure variation is in excess of 10% of the design. The 10% difference should be the difference between any two emitters in the entire system.

Fields should be laid out so that the irrigation lines follow the contour of the site. The DDR submittal should contain the proposed line layout so that flushing flows and static head calculations can be addressed on a field by field basis. Each field should define total flow (gpm) proposed, total length of emitter piping, emitter spacing, line spacing, total numbering of lines and total number of lines to be included per flushing. This layout information should be shown on a topographic map. All proposed main line sizes and lengths along with individual irrigation line lengths should be shown. All return piping sizes and lengths should also be shown and should not exceed manufacturers' specifications to insure equal distribution to each emitter. Emitter and line spacing should be in accordance with manufacturers' recommendations.

System should be self-draining to prevent freezing during the winter months. The Plan of Operation and Management should address disinfection and flushing of emitter lines to prevent solids build-up. Flushing of lines should be performed according to the manufacturers' recommendations but at minimum on a bi-monthly basis. **Velocities must be a minimum of 2 feet per second at the end of each irrigation or return line during the flushing operation.** Calculations supporting the 2 feet per second velocity requirement should be included in the DDR.

Satisfactory operation of the drip irrigation system is necessary to safeguard the health of the public and to insure that the wastewater effluent is disposed of in an environmentally sound manner. Emitter manufacturers must supply documentation that placing the emitter in the root zone of the cover crop will not interfere with the emitter performance. Emitters should be buried no less than 5 inches nor more than 7 inches from the surface for optimum nutrient uptake. Variance from this depth of burial will be evaluated on a case by case basis if supported by manufacturers' recommendations. All systems must be equipped with audible and visual alarms to signal system malfunctions. Telemetry systems should also be installed where the facility is not manned during normal working hours. Monitoring equipment must be provided to detect a 5% change in flow rate to any given field. If a change is detected which shows a 10% variance, evaluations must be performed to determine if it is a result of clogging filters, force main breaks, emitter clogging, leaks in field lines, a flush valve failure, etc. The Plan of Operation and Management should address what actions are required to correct any such problem should it occur. Pumping equipment must be provided with pressure and flow sensitive controls which will disengage pumps if a main breaks or clogs.

Prior to pumping to the drip field distribution system, the wastewater must be screened to remove fibers, solids and other matter which might clog drip emitters. As a minimum, screens with a nominal diameter smaller than the smallest flow opening in the drip emitter tubing should be provided. Screening to remove solids greater than one-third (1/3) the diameter of the smallest drip emitter opening is recommended.

The wastewater storage requirements as determined for spray application disposal methods will also be required for drip emitter disposal method. The design percolation rate and wastewater loading rate as determined in Chapter 16 of TDEC Sewage Criteria shall be the maximum rates allowed for drip emitter systems.

## 2.4 OTHER REQUIREMENTS

1. Wastewater treatment systems that require septic tanks for proper operation will be required to have the septic tanks pumped on a regular basis. The septic tank pumping schedule shall be presented in the DDR. The septic tanks shall be pumped out at least every three (3) years (more often if required for proper operation of the system). The DDR shall present the specific septage disposal location to be used for the wastewater system.

2. Section 16.1.3 of Chapter 16 of the TDEC Design Criteria is revised as follows:

The disposal site shall be relatively isolated, easily accessible and not susceptible to flooding. The disposal sites shall be located above the 10-year floor plain elevation and shall not be utilized when covered by flood waters. The wastewater treatment system shall be located outside or above the 100-year flood plain elevation. The primary disposal site shall be restricted so that its only acceptable use is for wastewater disposal. The use of the primary disposal site as a park, golf course, cemetery, or other public use is prohibited.

3. Section 16.3.2 of Chapter 16 of the TDEC Design Criteria is revised as follows:

BOD and TSS Reduction Disinfection - The primary wastewater disposal sites shall be closed to public access. Wastewater irrigated on sites closed to public access and restricted to only wastewater disposal sites must not exceed a 5-day BOD and total suspended totals of 30 mg/l as a monthly average. Disinfection to reduce fecal coliform bacteria to 200 colonies per 100 m/l is required. All wastewater treatment systems to achieve these parameters must be done in accordance with the Tennessee Department of Environment and Conservation Design Criteria.

4. Section 16.3.2, b. of Chapter 16 of the TDEC Design Criteria is hereby deleted.

5. Section 16.9.3, Buffer Zone Requirements, of Chapter 16 of the TDEC Design Criteria is revised as follows:

16.9.3 Buffer Zone Requirements

The objectives of buffer zones around disposal sites are to control public access, improve project aesthetics and, in case of spray irrigation, minimize the transport of aerosols. Since development of off-site property adjacent to the disposal site may be uncontrollable, the buffer zone must be the primary means of separating the field area from off-site property. Table 16-3 gives minimum widths of buffer zones for varying site conditions:

Table 16-3
On-Site Buffer Zone Requirements

| | Surface Spread | Sprinkler Systems (Edge of Impact Zone) Open Fields | Forested |
|---|---|---|---|
| Site Boundaries | 100 ft. | 100 ft. | 75 ft. |
| On-site streams, ponds and roads | 50 ft. | 50 ft. | 50 ft. |

6. Section 16.9, Land Area Requirements, of Chapter 16 of the TDEC Design Criteria is revised as follows:

In addition to the primary wastewater disposal site(s), a back-up or secondary wastewater disposal site(s) shall be provided. The back-up disposal site shall be sized based on the design wastewater flow rates and the specific design hydraulic loading rate for the back-up disposal site(s). The back-up disposal site shall be owned by the wastewater system owner.

The back-up wastewater disposal site(s) shall be protected to prevent encroachment of any unauthorized vehicles or equipment. No encumbrance or physical structure shall be placed in such a manner so as to interfere with the wastewater disposal site's intended purpose. No activity will be allowed on the back-up wastewater disposal site(s) that will alter the soil characteristics or the design percolation rates for each soil type.

7. Under no circumstances shall the treatment unit, storage pond, disposal site and back-up disposal site be installed upon properties encumbered by easements.

8. Under no circumstances shall the treatment unit, storage pond, disposal site and back-up disposal site be installed on properties with grades in excess of 15% slope.

## 2.5 <u>AUXILIARY DISPOSAL SITES</u>

The use of auxiliary disposal sites shall be permissible, provided the minimum primary disposal sites are provided and restricted to public access. The auxiliary disposal sites which may be open to public access shall include golf courses, cemeteries, green areas, parks and other public or private lands where public use occurs or expected to occur. Effluent applied on auxiliary disposal sites where public access is permitted must be treated to higher levels. The effluent applied on public access sites must not exceed a 5-day Biochemical Oxygen Demand and Total Suspended Solids of 10 mg/l, as a monthly average. Disinfection to reduce fecal coliform bacteria to 20 colonies/100 ml is required. Turbidity must be less than 3 NTU.

The pre-application treatment standards for effluent that is to be applied to public access areas will be reviewed by the TDEC and Williamson County on a case-by-case basis. More stringent pre-application treatment standards may be required as the TDEC deems necessary. TDEC recommends that the engineer give preference to pretreatment systems that will provide the greatest degree of reliability.

The following management/operation guidelines shall also apply to auxiliary disposal sites:

1. Provisions must be made to allow the wastewater treatment system operators to discontinue the pumping of effluent to the site in the event of an obvious plant upset.

2. Effluent water will be controlled to the extent that run-off as a direct result of over watering is prevented.

3. All effluent water valves or outlets will be appropriately tagged to warn the public that the water is not safe for drinking, bathing, or direct contact.

4. All piping, valves, and outlets will be marked to differentiate effluent water from domestic or other potable water. A different pipe material has been used to facilitate water system identification.

5. All effluent water valves, outlets, and sprinkler heads will be operated only by authorized personnel. Where hose bibs are present on domestic and effluent water lines, differential sizes will be established to preclude the interchange of hoses.

6. Adequate means of notification will be provided to inform the public that effluent water is being used. Such notification will include the posting of conspicuous warning signs with proper wording of sufficient size so as to be clearly read. At golf courses, notices will also be printed on score cards and at all water hazards containing effluent reuse water.

7. Tank trucks used for carrying or spraying effluent water will be appropriately identified to indicate such.

8. Application or use of effluent water will be done so as to prevent or minimize contact with the public with the sprayed material and precautions shall be taken to ensure that effluent reuse water is not being sprayed on walkways, passing vehicles, buildings, picnic tables, domestic water facilities, or areas not under control of the user. Also;

a. Application of the effluent water should be practiced during periods when the grounds will have maximum opportunity to dry before use by the public unless provisions are made to exclude the public from areas during and after spraying with effluent water.

b. Windblown spray from the application of effluent water should not reach areas accessible to the public.

c. Effluent water will be kept completely separate from domestic water wells and reservoirs.

d. Drinking water fountains will be protected from direct or windblown effluent water spray.

9. Adequate measures will be taken to prevent the breeding of flies, mosquitoes, and other vectors of public health significance during the process of effluent land application.

10. Operation of the effluent application facilities will not create odors or discharge, slimes, or unsightly deposits of sewage origin in places accessible to the public.

11. The following minimum buffer zones must be provided for all systems using auxiliary disposal sites:

a. a 50-foot buffer must be maintained between the edge of the wetted field area and all property lines.

b. A 300-foot buffer must be maintained between the wetted field area and any habitable structure.

c. A 50-foot buffer must be maintained between the edge of the wetted field area and any internal and external public roads.

d. Internal roads that are closed to public use do not require buffer zones. However, wastewater irrigation on these roads is prohibited.

e. A 25-foot buffer is required between the wetted edge of spray fields and the edge of any perennial lake or stream. A 25-foot buffer is required between spray fields and any channelized, intermittent watercourse.

f. A 150-foot buffer must be maintained between the property line and any part of the pre-application treatment facility and storage pond.

g. These buffer zone requirements may be increased when deemed necessary by TDEC or Williamson County.

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